Chapter 3N. Affected Environment and Environmental Consequences - Mosquitos and Public Health

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SUMMARY

This chapter discusses public health concerns related to transmission of disease by mosquitos and wildlife vectors in the Delta, describes mosquito control and abatement practices on the DW project islands, and assesses potential impacts of the DW project alternatives on mosquito production levels, mosquito abatement requirements, and transmission of diseases by wildlife.

The potential for creation of mosquito breeding habitat on the reservoir islands under Alternative 1, 2, or 3 was assessed for five habitat condition classes: full storage, partial storage, shallow storage, nonstorage, and shallow-water wetland. Shallow-water wetland conditions would have the greatest potential for producing problem numbers of mosquitos. The impact analysis presented in this chapter assumes, as a worst-case analysis, that water would be stored and released on the reservoir islands in a manner that would create the largest acreage of shallow-water wetlands during mosquito breeding seasons. If the reservoir islands are used for water transfers and banking, the frequency of storage periods is expected to increase and the frequency of nonstorage periods and shallow-water wetland periods is expected to decrease. However, conditions under water transfers and banking are speculative and were not used in the analysis of impacts. Under Alternative 1 or 2, seasonal and permanent wetland and seasonal flooded agricultural habitats that would be created on the habitat islands and managed for wildlife would also provide potential mosquito breeding sites during flood periods.

Implementing Alternative 1, 2, or 3 could result in the need for a significant increase in abatement levels on the DW project islands. Coordination with responsible mosquito abatement districts (MADs) and implementation of appropriate abatement practices would offset the creation of potential mosquito production sources under the DW project alternatives. The DW project would also contribute to the cumulative increase in mosquito abatement needs resulting from implementation of future projects in the Delta that benefit mosquito breeding conditions (e.g., projects for wetland habitat restoration) or that increase human populations near existing mosquito production areas (e.g., residential housing and marina developments). This cumulative impact is considered significant and unavoidable.

Implementing Alternative 1, 2, or 3 would also result in the beneficial impact of reducing or eliminating the need for mosquito abatement activities during full-storage periods on the reservoir islands.

Exposure of people to wildlife species that transmit diseases could increase on the habitat islands under Alternatives 1 or 2. However, this impact is considered less than significant because wildlife-transmitted diseases are not considered a significant risk to public health in the Delta, and the increase in risk under Alternative 1 or 2 would be minor.

The No-Project Alternative would benefit mosquito abatement needs by eliminating habitats considered problem mosquito production sources. However, increased corn production under the No-Project Alternative, primarily on Holland and Webb Tracts, could result in a substantial increase in mosquito production during the fall flooding. Coordination with responsible MADs and implementation of appropriate abatement practices would offset the effects of fall flooding practices under the No-Project Alternative.

INTRODUCTION

This chapter discusses impacts of the DW project on mosquito production levels; disease transmission by mosquito, tick, and wildlife vectors; and mosquito abatement efforts. These impacts would result from water storage operations on the DW reservoir islands and wildlife habitat management activities associated with management of the DW habitat islands. The HMP incorporated into the project description for Alternatives 1 and 2 provides for compensation habitat to be developed on the habitat islands to offset the effects of DW reservoir island operations on wildlife and on lands considered jurisdictional wetlands under Section 404 of the Clean Water Act. The impact assessment for Alternatives 1 and 2 is therefore based on the assumption that project implementation would include the establishment of compensation habitat acreages specified in the HMP. Under Alternative 3, all four DW project islands would be used as reservoirs, and the NBHA on Bouldin Island would be used to provide limited compensation habitat.

The following chapters and appendices provide more detailed information on existing habitat conditions on the DW project islands that affect the likelihood of disease transmission by vectors and provide information on predicted future habitat conditions for each alternative:

- Chapter 3G, "Vegetation and Wetlands";
- Appendix G2, "Prediction of Vegetation on the Delta Wetlands Reservoir Islands";
- Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands";
- Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives"; and
- Appendix G5, "Summary of Jurisdictional Wetland Impacts and Mitigation".

The 1990 draft EIR/EIS on the DW project did not address mosquitos or other public health issues. This chapter was added to the EIR/EIS in response to comments on the 1990 draft EIR/EIS from MADs and others.

AFFECTED ENVIRONMENT

This section describes conditions affecting production of mosquitos, and disease transmission by mosquitos and other vectors on the DW project islands. Information on habitat conditions that govern the production of mosquitos is based in part on information collected for the 1990 draft EIR/EIS and has been updated to current conditions where these changes would affect the impact analysis.

As a result of land management decisions made since 1988, some changes in agricultural land use and vegetation conditions on the islands have occurred. Some of these changes were made in response to annual fluctuations in agricultural market conditions. Because some of the changes resulted from project-related actions and influences, information from the 1990 draft EIR/EIS (based on 1988 conditions) provides the most reliable description of typical preproject habitat conditions to use in assessing the impacts of the DW project alternatives.

Sources of Information

Information on mosquito ecology, control methods, existing levels of abatement, and midge production was collected from documents issued by MADs, mosquito ecology and abatement literature, and contacts with the San Joaquin County MAD (SJCMAD) and the Contra Costa MAD (CCMAD). DHS provided information on the status of Lyme disease, bubonic plague, and rabies in the Delta region.

Status of Mosquito Control in the Delta

Mosquito Breeding Conditions in the Delta

All species of mosquitos require standing water to complete the growth cycle; therefore, any body of standing water represents a potential mosquito breeding site. Mosquitos are produced year round on Delta islands, but mosquito production diminishes substantially during the cool season (typically late October through April) (Lucchesi and Kramer pers. comms.).

Water quality affects the productivity of a potential mosquito breeding site. Typically, water bodies with poor circulation, higher temperatures, and higher organic content (and therefore with poor water quality) produce greater numbers of mosquitos than water bodies having good circulation, lower temperatures, and lower organic content (Collins and Resh 1989). Additionally, irrigation and flooding practices may influence the level of mosquito production associated with a water body. Typically, water bodies with water levels that slowly increase or recede produce greater numbers of mosquitos than water bodies with water levels that are stable or that rapidly fluctuate.

Among the habitat types on the DW project islands and in the Delta, two general classes of habitats, open-water and flooded habitats, can provide suitable conditions for mosquito production.

Open-Water Habitats. Open-water habitats on the DW project islands include perennially inundated ditches, sloughs, and ponds (Table 3N-1). The shallow edges of sloughs, ditches, and ponds are typically lined with riparian or marsh vegetation.

Sloughs and ponds that have good water quality (good circulation, low temperatures, and low organic content) usually do not provide optimum breeding habitat for mosquitos. Permanent bodies of open water with these characteristics typically sustain stable nutrient content and support rich floral and faunal species diversity, including mosquito predators and pathogens. Wave action across larger bodies of water in the Delta physically retards mosquito production by inhibiting egg laying and larval survival (USFWS 1992).

Mosquito larvae prefer stagnant water and the protected microhabitats provided by stems of emergent vegetation. Therefore, if not properly maintained, ditches can be major producers of mosquitos. Periodic dredging of ditches substantially reduces mosquito production by enhancing water circulation and preventing encroachment of emergent vegetation into ditch channels (Lucchesi pers. comm.).

Open-water habitats existing on the DW islands support established populations of mosquitofish (*Gambusia affinis*) and other mosquito predator populations, including predacious insects such as backswimmers and dragonflies, that assist in suppressing mosquito production at these sites by feeding on mosquito larvae at the water's surface (Lucchesi and Kramer pers. comms.).

Flooded Habitats. Flooded habitats on the DW project islands and in the Delta include exotic and freshwater marshes and agricultural lands that may seasonally retain surface water (Table 3N-1). These habitats are inundated by subsurface or surface irrigation or exist at the edges of ditches, sloughs, and ponds.

Mosquitos are adapted to breed during periods of temporary flooding and can complete their life cycles before water evaporates and predator populations become well established (USFWS 1992). Water management practices associated with agriculture and creation of seasonal wetlands for waterfowl use result in the types of flooding that can produce problem numbers of mosquitos (USFWS 1992, Kramer and Lucchesi pers. comms.).

Delta agricultural lands flooded to pre-irrigate fields, control weeds, or attract migrating and wintering waterfowl typically produce problem numbers of mosquitos from May through October. For example, substantial increases in mosquito production have been recorded in agricultural fields on Bouldin Island that are flooded in late summer to control weeds (Lucchesi pers. comm.). Mosquito production can be reduced substantially if fields are not flooded until the end of October, when temperatures usually drop enough to curtail mosquito production (Kramer and Lucchesi pers. comms.).

Most crop irrigation does not produce appreciable numbers of mosquitos because water is typically applied rapidly and removed from fields (USFWS 1992). Irrigated pastures, however, are typically nutrient rich and are irrigated for 7-10 days. This environment is conducive to production of large numbers of mosquitos and provides sufficient time for them to complete their life cycles. Therefore, irrigation of pastures may result in a severe mosquito problem if the pastures are flooded at any time from May through October (Kramer pers. comm.).

Mosquito Abatement Districts

The DW project islands are located in two MADs. Bouldin and Bacon Islands are within the jurisdiction of SJCMAD, and Holland and Webb Tracts are within the jurisdiction of CCMAD. Both MADs receive most of their revenue from property taxes and are responsible for controlling mosquitos as pest species and as disease vectors (Kramer and Lucchesi pers. comms.).

California law dictates that if a mosquito source exists as a result of human-made conditions, the party responsible for those conditions is liable for the cost of abatement. The law is enforced at the discretion of the responsible MAD (California Health and Safety Code Sections 2200-2294). In 1993, CCMAD implemented a policy that would require landowners to either provide abatement or enter into a service contract with the district if abatement costs exceed $500 per mosquito production source (Kramer and Waletzko pers. comms.). Although SJCMAD does not charge landowners for abatement, the district maintains an option to do so if funding for the MAD declines (Lucchesi pers. comm.).

CCMAD has adopted the California Mosquito and Vector Control Association's draft Wetlands Policy Statement as its policy for wetland creation and restoration projects. Elements of this policy directly applicable to the DW project instruct MADs to:

> participate in all levels of wetlands planning in order to identify and minimize all real or potential public health impacts created by mosquitoes and other vectors; work cooperatively with all responsible participants on any wetlands project to achieve as many of the stated goals of the project as possible; and provide the necessary information to ensure that any mosquito or other vector surveillance and control funds are provided for in the necessary Operation and Maintenance Plan of all wetlands projects. (Waletzko pers. comm.)

SJCMAD has not adopted specific policies or guidelines for wetland creation and restoration projects; however, general abatement policies are codified in Division 15 of the SJCGP (Lucchesi pers. comm.).

Mosquito Species of Concern

On Delta islands, SJCMAD and CCMAD are primarily concerned with controlling seven species of mosquitos that can transmit malaria and several types of encephalitis or cause a substantial nuisance in surrounding communities.

The floodwater mosquito (*Aedes melanimon*) and the pasture mosquito (*Aedes nigrormaculis*) are the primary nuisance species produced on the DW project islands. These mosquitos commonly breed in irrigated pastures and seasonal wetlands and may travel several miles from breeding areas in search of hosts (Kramer and Lucchesi pers. comms.). Floodwater mosquitos are potential vectors of California encephalitis, and both species are potential vectors of western equine encephalitis and St. Louis encephalitis (Bohart and Washino 1978).

The encephalitis mosquito (*Culex tarsalis*) breeds in almost any freshwater pond. Birds appear to be the primary hosts of this species, but domestic animals and humans serve as occasional hosts (Bohart and Washino 1978). This species is the primary carrier in California of western equine encephalitis, St. Louis encephalitis, and California encephalitis and is considered the most important disease vector in the state (Sacramento-Yolo County Mosquito Abatement and Vector Control District 1990).

The western malaria mosquito (*Anopheles freeborni*) is the primary vector of malaria in the western United States. Algal mats that form in stagnant water are the preferred egg-laying habitat for this species (Stroh pers. comm.). Depending on ambient temperatures, development from the egg to the adult stage may take 12-20 days. In the Delta region, the western malaria mosquito may migrate up to 5 miles from production areas (Bohart and Washino 1978).

The mosquito *Aedes dorsalis* breeds in intertidal marshes, which are not found on the DW project islands. *A. dorsalis* can travel up to 20 miles from breeding areas, however, and can become a major pest in the project area if large numbers move inland (Bohart and Washino 1978, Kramer pers. comm.). This species is a suspected vector of California encephalitis (Bohart and Washino 1978).

The cool-weather mosquito (*Culiseta inornata*) is most abundant in fall and spring (Bohart and Washino 1978). This species feeds primarily on domestic animals and has been identified as a vector of western equine encephalitis. It is not considered an important public health vector, however, because humans are not preferred hosts and the species has not been found to carry western equine encephalitis in California.

House mosquitos (*Culex pipiens*) usually breed in waters with a high content of organic material and generally do not travel far from breeding sites (Bohart and Washino 1978, Sacramento-Yolo County Mosquito Abatement and Vector Control District 1990). Although birds are their primary hosts, house mosquitos will bite people. They are the primary vector of St. Louis encephalitis outside the western United States but are not considered a problem vector of St. Louis encephalitis in California (Bohart and Washino 1978).

Mosquito Control Methods

SJCMAD and CCMAD use a combination of various abatement procedures to control mosquitos, each of which may have maximum effectiveness under different habitat conditions or periods of the mosquito life cycle (Kramer and Lucchesi pers. comms.).

Criteria for Determining the Need for Control at a Mosquito Source. According to MADs, state laws and regulations require that mosquitos be controlled if diseases transmitted by mosquitos are identified in or near human populations, or if surveillance of mosquito populations for the incidence of mosquito-transmitted diseases indicates the likelihood of transmission (USFWS 1992). The decision to control mosquitos as a nuisance to human populations is at the discretion of each MAD. Factors influencing this decision may include the number of service calls received from a given locality, the proximity of mosquito sources to population centers, the availability of funds for abatement, the density of mosquito larvae present in a mosquito production source, and the number of adult mosquitos captured per night in light traps (USFWS 1992, Waletzko and Lucchesi pers. comms.).

Once a recurring mosquito production source has been identified, abatement schedules are often adopted and maintained for that source (USFWS 1992, Waletzko pers. comm.). SJCMAD and CCMAD monitor larval and adult mosquito populations at known mosquito production sources to determine when problems may occur and when treatment should take place (Kramer and Lucchesi pers. comms.).

Biological Control. Mosquitofish are the primary biological control used by SJCMAD and CCMAD. Populations of mosquitofish bred in captivity are stocked in open water and flooded habitats; additionally, naturalized populations of mosquitofish in Delta waters enter DW island waters through irrigation and drainage ditches. Mosquito larvae, however, are not the preferred food item so biological controls are not effective in most situations unless they are used as part of an integrated mosquito control program (Kramer pers. comm.). Additionally, if emergent vegetation is established in dense stands, it can provide an ideal substrate for mosquito production and physically prevent mosquitofish from feeding on mosquito larvae (USFWS 1992, Kramer pers. comm.).

Source Reductions. Source reductions are management actions that physically eliminate environmental conditions necessary for mosquito production. These actions include dewatering ponded areas, improving drainage on cultivated fields, removing emergent vegetation from drainage ditches, and improving water circulation (USFWS 1992). SJCMAD and CCMAD have ongoing programs of source reduction (Kramer and Lucchesi pers. comms.).

Pesticides. Pesticides that are designed to control mosquito larvae or adults are available to SJCMAD and CCMAD. However, because of public concerns regarding environmental effects, SJCMAD and CCMAD have reduced their reliance on these chemicals as part of their abatement programs (Kramer and Lucchesi pers. comms.).

SJCMAD uses several types of organophosphorus and pyrethrum pesticides to control adult mosquitos in populated areas and at mosquito production sources (Lucchesi pers. comm.). Controlling mosquitos in larval stages, however, is the preferred method because mosquitos are removed before they can reproduce and because treating larvae is less costly than treating adults (USFWS 1992).

Bacillus thuringiensis israelensis (Bti) is a bacterial larvicide that, although expensive, is a preferred method of treatment in wetlands where removal of nontarget species may be a concern (USFWS 1992). Bti is effective only against first and second larval instar stages and does not work well in the organic soils common in the project area (Kramer pers. comm.).

Methoprene is sometimes used by CCMAD to control larvae on irrigated pastures (Kramer pers. comm.). Methoprene is a growth-regulating chemical that mimics insect juvenile hormone in mosquito larvae and prevents larvae from developing into adults. Methoprene usually dissipates from the environment within 48 hours after application (Sacramento-Yolo County Mosquito Abatement and Vector Control District 1990).

Rapidly dissipating petroleum-based oils are also used to control larvae. These oils form an impenetrable film on water surfaces, preventing larvae from obtaining oxygen. SJCMAD and CCMAD frequently use oils to control larvae on irrigated pastures (Kramer and Lucchesi pers. comms.).

Ecological Control. Ecological control methods take advantage of ecological relationships to reduce the population size or production rate of mosquitos. Ecological control methods include designing irrigation systems to rapidly supply and remove water, manipulating water levels in wetlands, and maintaining constant water quality. (Collins and Resh 1989.)

Mosquito Habitat Conditions on the DW Project Islands

Potential mosquito breeding habitats existing on the DW project islands include grain and seed croplands, exotic and freshwater marshes, irrigated pastures, ditches and sloughs, and ponds. Except for permanent ponds, these habitats provide suitable mosquito breeding sites only during periods when surface water is present. Other habitat types on the DW project islands, including riparian woodlands, herbaceous uplands, perennial croplands, fallow fields, and developed lands, typically do not produce substantial numbers of mosquitos (Table 3N-1).

Bacon Island

Most of Bacon Island is intensively farmed, primarily to produce potatoes and asparagus (see Table 3G-4 in Chapter 3G, "Vegetation and Wetlands"). There is no irrigated pasture on the island, less than 2% of the island is open-water habitat, and less than 1% is marsh (Table 3N-1).

In recent years, SJCMAD has treated approximately 3.5 acres of ponds receiving tailwater from potato processing on Bacon Island to control house mosquitos (Figure 3N-1). SJCMAD treats tailwater ponds with Bti and oil when the ponds are receiving discharge and stocks the ponds with mosquitofish during nondischarge periods (mosquitofish cannot survive in water discharged from potato-processing plants). (Lucchesi pers. comm.)

SJCMAD receives a few service requests per year from resorts near Bacon Island during holiday periods when resort visitation is greatest. Generally, however, SJCMAD does not consider Bacon Island a problem mosquito-production area because most of the island is farmed to produce crops that are cultivated in a manner that typically does not promote mosquito production (Lucchesi pers. comm.).

Webb Tract

Approximately 49% of Webb Tract is farmed to produce corn and small grain crops. Approximately 17% of the island is marsh, 3% is open water, and 1% is irrigated pasture (Table 3N-1). The remainder of the island consists mostly of riparian upland habitat types.

CCMAD does not consider Webb Tract a problem mosquito production source and has not implemented mosquito control measures on the island in recent years (Waletzko pers. comm.).

Bouldin Island

The agricultural land on Bouldin Island (nearly 76% of the island) is farmed to produce corn, wheat, and sunflowers. Open-water and marsh habitats constitute approximately 4% of the island (Table 3N-1).

Mosquito production on Bouldin Island generates service calls to SJCMAD when the mosquitos move east from the island to Tower Park Marina at Terminous (Lucchesi pers. comm.). During the past 5 years, SJCMAD has averaged five to seven service calls per year, primarily during August and September. During September 1992, however, the district received 18 service requests. SJCMAD attributes the increase to earlier-than-normal flooding of harvested wheat fields for weed control during warm fall weather (Lucchesi pers. comm.).

SJCMAD believes that water management practices associated with corn cultivation on Bouldin Island from late summer through October create habitat suitable for producing problem numbers of mosquitos (Lucchesi pers. comm.). The year before corn is planted, fields are generally shallow-flooded from about mid-September to October 1 for pre-irrigation and weed control, and they are drained by the end of December. Flooding before the onset of cooler weather (usually by November 1) creates conditions conducive to producing large numbers of pasture and western malaria mosquitos. SJCMAD annually treats these areas to control mosquito production and stocks fields with mosquitofish immediately after they are flooded (Lucchesi pers. comm.).

In fall 1992, approximately 1,000 acres on Bouldin Island were flooded and treated by SJCMAD with aerial applications of Bti (Wilkerson and Lucchesi pers. comms.). Adulticides were applied around the perimeters of some breeding areas to remove adult mosquitos before they could breed, and at Tower Park Marina on adjacent Terminous Tract to alleviate mosquito nuisances (Figure 3N-1) (Lucchesi pers. comm.).

Holland Tract

Approximately 18% of the project area on Holland Tract is farmed in corn and wheat, 11% is irrigated pasture, and approximately 3% is open-water and freshwater marsh habitats (Table 3N-1).

Floodwater, pasture, *Aedes dorsalis*, and encephalitis mosquitos are the most prevalent species of mosquitos on the island. CCMAD considers irrigated pastures to be major and recurring mosquito production sources on Holland Tract (Kramer pers. comm.). CCMAD does not consider the project area for Alternatives 1 and 2 on Holland Tract to be a problem mosquito production source. During 1989-1991, however, CCMAD spent approximately $37,000 and 58 work days annually to inspect mosquito production sources and to control mosquitos on approximately 520 acres of irrigated pastures located in the southwestern quadrant of Holland Tract (Figure 3N-1). These pastures are frequently flooded for 7-10 days and produce large numbers of floodwater and pasture mosquitos (Waletzko pers. comm.). If monitoring of production sources indicates that larvae densities exceed CCMAD's established mosquito production standards, pastures are treated with oil or methoprene (Kramer pers. comm.).

Mosquitos typically migrate north from Holland Tract and frequently cause nuisance problems in the Oakley area to the west and the Discovery Bay area to the south (Kramer pers. comm.). From 1989 through 1991, CCMAD averaged 68 mosquito service request calls per year from locations within a 5-mile radius of Holland Tract (Waletzko pers. comm.).

Other Public Health Concerns

Other public health concerns on the DW project islands include midge production and the transmission of Lyme disease by ticks, bubonic plague by fleas, and rabies by wildlife and other animals. However, as described below, none of these public health concerns are considered a risk to public health in the Delta.

Midge Production

Midges are nonbiting insects that breed in ponded water and, as adults, are similar in appearance to mosquitos. Large populations of midges can be a nuisance to humans and have been known to swarm in large numbers, causing traffic accidents along SR 4 by reducing driver visibility (Stroh pers. comm.).

No public agency is responsible for controlling midge production, and the control of midges is not explicitly mandated by state law. If midges become a significant nuisance or pose a safety hazard, however, the owner of the land where midges are produced may be held liable for midge control under current state health and safety codes (Lucchesi pers. comm.).

Lyme Disease

Lyme disease is transmitted to humans by some species of ticks. In California, incidences of Lyme disease are most frequently reported from the coastal foothill region. Lyme disease is rare in the Sacramento and San Joaquin Valleys and is considered by DHS to be a very low risk to public health in the Delta area. (Reilly pers. comm.)

Bubonic Plague

Bubonic plague is transmitted to humans by fleas that have fed on ground squirrels and other rodents infected with the plague bacteria. The plague in California occurs mostly in the foothill regions of the Sierra Nevada and coastal ranges at elevations above 4,000 feet. Incidence of bubonic plague in the Central Valley is very rare and the plague is considered by DHS to be a very low risk to public health in the Delta area (Reilly pers. comm.).

Rabies

Rabies is a viral disease of mammals that is, except under unusual circumstances, transmitted through the bite of an infected animal. In the Delta, skunks, gray foxes, and bats are the main carriers of the disease. Rabies is endemic throughout California but is not considered by DHS to be a high risk in the Delta area (Reilly pers. comm.).

IMPACT ASSESSMENT METHODOLOGY

Changes in mosquito abatement requirements for the DW project islands were evaluated through comparison of predictions of future mosquito breeding conditions under the DW project alternatives with existing mosquito abatement requirements. Predictions of future mosquito breeding conditions are based on predicted future habitat conditions, which are described in Appendices G2, "Prediction of Vegetation on the Delta Wetlands Reservoir Islands", and G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands".

The risks to public health associated with midge production and transmission of Lyme disease, bubonic plague, and rabies are low, and risk levels are not expected to substantially change with implementation of the DW project alternatives. These public health concerns, therefore, are not considered to be potential impacts of the DW project alternatives.

Analytical Approach and Impact Mechanisms

Impact mechanisms include habitat-type conversions and changes in water management practices resulting from project implementation. Proposed management of reservoir islands and creation of wetland, pasture, and cornfield habitats on the habitat islands may increase or decrease the amount of potential breeding habitat for mosquitos, wildlife-borne diseases, or other pests. Changes in the timing of water application and withdrawal on the DW project islands may increase or decrease the amount of potential breeding habitat for mosquitos or other pests. Changes in land and water management may increase the presence of wildlife species, particularly migratory waterfowl, that are hosts for transmittable diseases.

The following were used to predict future mosquito breeding conditions and abatement requirements for the DW project islands:

- literature on mosquito ecology and control methods;
- contacts with SJCMAD and CCMAD personnel knowledgeable about the mosquito ecology, mosquito control problems, and mosquito control history of Delta islands; and
- information on acreages of habitat types and flood conditions to be created on the DW project islands (see Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands", and Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives").

In the analysis, the growing season for vegetation and the breeding periods for mosquitos were assumed to extend from May through October (Lucchesi and Kramer pers. comms.). Additionally, predictions of the frequency and extent of water storage, nonstorage, and shallow-flooding conditions on the reservoir islands under the DW project alternatives were essential to the analysis of mosquito breeding potential. Although farming will cease on the DW project islands, potential exists for some level of continuing subsidence on these islands. As a result, the water storage capacity of the reservoir islands could increase in future years. The rate of subsidence, however, would be substantially less than under existing conditions. Reduced rates of subsidence and increased water storage capacity on the reservoir islands would not be expected to substantially increase or decrease the level of mosquito production from levels predicted in this analysis.

Although additional water associated with water transfers may be banked on the reservoir islands, the frequency and magnitude of nonproject water-banking activities is unknown and is not included in this analysis (see Chapter 2, "Delta Wetlands Project Alternatives"). Increased periods and depths of inundation that would be associated with water banking activities, however, may reduce mosquito production levels during banking periods (see "Full Storage" and "Partial Storage" below, under "Mosquito Breeding Conditions").

Reservoir Islands

The frequencies of future periods of water storage, nonstorage, and shallow flooding on Bacon Island and Webb Tract are difficult to predict because conditions would vary with water availability in the Delta. Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives", presents results of simulations of water storage operations under the DW project alternatives based on Delta flows recorded over the 70-year period from 1922 to 1991. These simulations are used to predict the frequency of island flooding conditions in future years. The future availability of water for storage, however, may not follow simulated storage frequencies.

Sequence of Water Storage Operations. Prediction of future conditions on a particular reservoir island is further complicated because DW may sequentially fill the reservoir islands and, when feasible, rotate the sequence of island flooding between years to maximize the opportunity for creating shallow-water wetland habitats (see Chapter 2, "Delta Wetlands Project Alternatives"). Alternately, DW may simultaneously fill the reservoir islands when water is available for diversion onto both islands. The analysis of mosquito breeding conditions is based on the assumption that the reservoir islands would be sequentially filled to provide the greatest opportunity to create shallow-water wetlands and thus, as a worst-case scenario, the greatest potential for creating mosquito breeding habitat. In the assumed order of sequential filling for Alternatives 1 and 2, Bacon Island (having the greatest storage capacity) would be filled to capacity before water is diverted to Webb Tract, and Webb Tract would be emptied before water is released from Bacon Island. Under Alternative 3, the order of diversion would be Bacon Island, Webb Tract, Bouldin Island, and Holland Tract; these islands would be emptied in the reverse order.

Definitions of Habitat Condition Classes for the Reservoir Islands. Based on mosquito production potentials associated with different ranges of reservoir water volumes, reservoir volumes were divided into the five habitat condition classes: full storage, partial storage, shallow storage, nonstorage, and shallow-water wetland.

Descriptions of these habitat condition classes are given in Appendix G2, "Prediction of Vegetation on the Delta Wetlands Reservoir Islands". However, the mosquito production analysis assumes sequential diversions, with the reservoir islands filled to storage capacity, and the vegetation analysis assumes simultaneous diversions, with "full storage", as defined in Appendix G2, being achieved before full storage capacity is filled. Therefore, the total storage volume when all reservoir islands are at full storage would be greater for this analysis than that described in Appendix G2. For this analysis, the reservoir islands would be completely inundated at a total storage volume of 189 TAF under Alternative 1 or 2 and 396 TAF under Alternative 3.

Habitat Islands

Water management to maintain lake, permanent wetland, seasonal wetland, and agricultural habitats on Bouldin Island and Holland Tract under Alternatives 1 and 2 is described in Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands". The annual sequence of water management on the habitat islands would be followed according to predetermined flooding schedules established in April of each operating year.

No-Project Alternative

Predictions of island conditions under the No-Project Alternative are based on the results of a feasibility study prepared for DW by The McCarty Company, Diversified Agricultural Services (McCarty pers. comm.). This report outlines island-by-island recommendations for intensifying the production and yield of various crops. Diversifying crops and emphasizing perennial crops are general recommendations for all islands.

Criteria for Determining Impact Significance

SWRCB and the Corps determined that for this analysis, an alternative would be considered to have a significant impact on mosquito abatement if habitat changes would necessitate increasing levels of mosquito abatement programs in order to maintain mosquito populations at preproject levels. Habitat changes that could result in a substantial decline of available mosquito breeding habitat or greater efficiency of CCMAD or SJCMAD abatement programs are considered to be beneficial impacts.

An alternative would also be considered to result in a significant impact if it would substantially increase potential exposure of people to wildlife-transmitted diseases considered a high health risk in the Delta area by DHS.

IMPACTS AND MITIGATION MEASURES OF ALTERNATIVE 1

Impacts of Alternative 1 were analyzed for the period during which potential problem numbers of mosquitos could be produced on the DW project islands (May 1 through October 31) (Kramer and Lucchesi pers. comms.). As stated above, because DW may rotate the sequence of filling the reservoir islands, the analysis was conducted for the project operating regime that would create the greatest potential for production of problem numbers of mosquitos.

Mosquito Breeding Conditions

Bacon Island and Webb Tract

Tables 3N-2 and 3N-3 present the monthly frequency with which each flood habitat condition class would occur on the reservoir islands during the mosquito breeding season. Mosquito breeding conditions would be the same on Bacon Island and Webb Tract for each habitat condition class, but the frequency with which each class occurs on each island may differ. The frequency of full-, partial-, and shallow-storage periods would be expected to increase, and nonstorage and shallow-water wetland periods would be expected to decrease on both islands, however, if the DW reservoir islands were used for storage of water for transfer or for water banking (see Chapter 2, "Delta Wetlands Project Alternatives"). Because the frequency and magnitude of such activities is uncertain at this time and these activities would require separate authorization, their impacts on mosquito production and abatement are not assessed in this document.

Full Storage. During full-storage periods, mosquito production on the reservoir islands would be minimal. At full storage, water depths would exceed 10 feet over most of the islands and, because the water level would be at the riprapped levee slopes, reservoir edges would lack emergent vegetation that could be used as breeding areas by problem numbers of mosquitos. As described above, deep, open-water habitats are poor mosquito breeding areas because the wave action generated over large water bodies disrupts the ability of larvae to penetrate the water surface and because vegetation necessary for egg laying and cover for larvae is lacking.

Water would be diverted onto the reservoir islands as it becomes available in the Delta and would be discharged into the Delta during periods of water demand. Consequently, reservoir water would be circulated and water levels would fluctuate as water is diverted or discharged. Periods of good water circulation and rapid changes in water levels on the reservoir islands would probably disrupt mosquito production during some full-storage periods (USFWS 1992, Lucchesi pers. comm.).

Partial Storage. Partial-storage conditions would provide shallow to deep water storage pools, exposed island bottoms, and above-water riprapped levee slopes. Reservoir island habitat conditions will vary more under partial-storage conditions than under other storage conditions because, during partial-storage periods, a greater range of reservoir sizes and water depths can occur. Partial-storage reservoir conditions would range from saturated soils at shorelines to water depths of over 10 feet. Portions of the reservoir with depths over 3 feet would not encourage breeding of problem numbers of mosquitos because habitat conditions would be similar to those described for full-storage periods.

Mosquito production could occur in shallow-water areas near the edges of the reservoir in a partial-storage condition. During May partial-storage periods in most years, however, little or no vegetation would be present to provide egg-laying sites or cover for larvae, or to break up wave action in shallow water areas because previous storage or flooding to create shallow-water wetlands would have removed vegetation from island bottoms.

The rate at which herbaceous vegetation would become reestablished on islands following complete or partial drawdowns of the reservoir is unknown. Vegetation density during nonstorage and partial-storage periods is expected to be reduced as a result of gradual loss of seeds and other plant propagules because of deterioration from inundation, export from the islands during water releases, and periodic disruption of seed production by water storage during the growing season. To enhance the value of shallow-water wetlands, DW may choose to periodically seed islands during spring and summer nonstorage periods with watergrass and other food plants for waterfowl.

For partial-storage periods, the potential for substantial mosquito production is greatest during July and August. In years when July and August partial-storage periods follow one or more months of nonstorage, dense vegetation could become reestablished on the island bottoms. Shallow and relatively stable storage pools present during these months in some years, coupled with dense vegetation and high ambient temperatures, would create optimal mosquito breeding conditions.

Mosquito breeding conditions on portions of island bottoms exposed during partial-storage periods would be the same as those described below for nonstorage conditions.

Shallow Storage. Shallow storage occurs when stored water volumes are equal to water volumes used to create shallow-water wetlands. Mosquito breeding conditions under shallow storage would be similar to those described for partial storage except that the reservoir area available for breeding would be smaller. Shallow storage that occurs after nonstorage during the growing season would create vegetation conditions similar to those of shallow-water wetland periods (described below).

Nonstorage. Nonstorage periods follow complete water releases from the reservoir islands and precede fall planned flooding to create seasonal wetlands. Islands would be constructed with a drainage system to allow the lowest portions of island bottoms to drain. Drainage would reduce ponding in depressions at elevations above the elevation of the drawdown pool, eliminating potential sites for mosquito production. Some level of mosquito production, however, may occur in undrained pools, small pools that result from seepage onto the island, and areas with saturated soils.

Following drawdown, some mosquito production may occur in saturated areas. Mosquito breeding conditions, however, would not be optimal because most areas of the island bottoms would lack sufficient vegetation. During periods of nonstorage from April through October, plants would be expected to germinate within the first 30 days of nonstorage, although bare ground would be the predominant condition. Vegetation would grow rapidly following germination. Substantial mosquito production may occur in small pools or areas of saturated soils that are revegetated.

Permanent open-water habitat in borrow areas and in the drainage circulation network would be created under Alternative 1. Conditions in this habitat would be less than favorable for mosquito production because water depths would range between 2 feet and 4 feet, and insufficient time would exist for emergent vegetation to become established before subsequent deep-water storage would occur.

Shallow-Water Wetlands. Shallow-water wetland conditions would occur during periods when no storage occurs and water is diverted onto the reservoir islands to flood vegetation and attract waterfowl and other wetland-associated wildlife. Shallow-water wetlands would be created at DW's discretion. For this analysis, however, it was assumed that DW would create shallow-water wetlands each year in which no water had been stored for 60 or more consecutive days during the growing season (May through October). Approximately 3,700 acres on Bacon Island and 3,850 acres on Webb Tract could be managed as shallow-water wetlands (JSA 1993).

Shallow-water wetlands would be managed until the first water storage period or through April if no storage occurs. Wetlands would be flooded between September and November (flooding dates would vary with vegetation maturity) to create shallow-water wetlands. DW will construct an inner levee system on the reservoir islands that would maintain at least 65% of the islands in a flooded condition, maintain mean water depths of 1 foot over 50% of the flooded area, and allow water to circulate through wetlands. Open-water habitats in borrow areas and the drainage circulation network would be as described for nonstorage conditions. Higher elevation fields around the perimeters of islands would be filled first and the water allowed to flow through weirs to lower elevation fields and toward island interiors. This procedure would provide some water circulation, improving water quality and reducing the potential for substantial mosquito production. In addition, the network of inner levees, the drainage circulation network, pumps, and other water control structures associated with the project would allow rapid drainage of shallow-water wetlands for mosquito control.

Problem numbers of mosquitos could be produced for as long as 60 days when seasonal wetlands are flooded on September 1. If DW does not seed the islands, mosquito breeding conditions would be less than optimal because vegetation would be sparse and water would have greater wave action than in shallow-water wetlands that are seeded (see Chapter 3G, "Vegetation and Wetlands").

Bouldin Island and Holland Tract

Habitats would be created and managed on Bouldin Island and Holland Tract primarily to offset project impacts on Swainson's hawks, greater sandhill cranes, wintering waterfowl, and jurisdictional waters of the United States. Seven habitat types that could potentially produce problem numbers of mosquitos would be created on the habitat islands: seasonal managed wetland and mixed agriculture/seasonal wetland, corn rotated with wheat, pastures/hayfields, seasonal ponds, permanent lakes, emergent marsh, and borrow ponds.

A detailed description of how the habitat islands would be designed and managed is contained in DW's habitat management plan, presented in Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands".

Tables 3N-4 and 3N-5 present the acreage of each habitat type that would be flooded during the mosquito breeding season (May 1-October 31). Up to 25% of each seasonal wetland area and agricultural field may be left dry. Acreages of each habitat type differ between islands; however, mosquito breeding conditions associated with each habitat type are the same.

Seasonal Managed Wetlands and Mixed Agriculture/Seasonal Wetland. Approximately 3,760 acres of seasonal managed wetlands and mixed agriculture/seasonal wetland habitat would be developed on the habitat islands. These habitat types would be managed under identical flood regimes, and watergrass and smartweed are expected to be the dominant plant species. However, narrow strips of corn would be planted throughout mixed agriculture/seasonal wetland habitats.

Wetland areas would consist of a minimum of 65 acres and would be designed to allow rapid drawdown or flooding if necessary to control mosquito production. Additionally, water would be circulated through wetlands to maintain water quality and inhibit mosquito production.

These wetland habitats would be slowly flooded through fall and winter to average depths of 12 inches and would be slowly drawn down from early spring through May. When first flooded, wetland areas would support dense stands of emergent vegetation. After 6-8 weeks of flooding, most vegetation is expected to fall over and become submerged because of wave action and waterfowl foraging. Flooding of these habitats potentially could produce problem numbers of mosquitos from September 1 through October 31. Wetlands that remain flooded from May 1 to May 30, however, would lack emergent vegetation. This condition, in combination with wave action, would be expected to substantially reduce the potential for production of problem numbers of mosquitos.

Corn Rotated with Wheat. Approximately 2,585 acres of corn rotated with wheat would be developed on each island. Each cornfield and wheat field would consist of at least 65 acres and would be designed to allow rapid drawdown or flooding if necessary to control mosquito production. Additionally, water would also be circulated through fields to maintain water quality and inhibit mosquito production.

Fields would be slowly flooded through fall and winter to depths averaging 12 inches and would be slowly drawn down from early winter through April 15. Between 50% and 67% of fields would be harvested in 120-foot-wide strips. Unharvested corn and wheat would be allowed to remain standing until wave action, root deterioration, and waterfowl foraging caused stalks and stems to fall over. Cornfields and wheat fields potentially could produce problem numbers of mosquitos from September 1 through October 31. Some mosquito production may occur during summer irrigation periods; however, production levels would be similar to those associated with corn and wheat irrigation practices elsewhere in the Delta.

Pasture/Hay. Approximately 205 acres of pasture/hay fields would be maintained on the habitat islands. Pastures would be shallow-flooded after the mosquito breeding season from November to February. During irrigation periods from May through early summer, however, substantial numbers of mosquitos could be produced if flood irrigation water is allowed to remain on fields for more than 3 days.

Seasonal Ponds. Approximately 134 acres of small, 2- to 10-acre seasonal ponds would be created to provide brood water for ducks from February through July. Between 70% and 100% of pond area would be flooded to depths of 6-12 inches.

Seasonal ponds could potentially produce substantial numbers of mosquitos because they would be flooded during periods of high ambient temperatures, would support emergent vegetation, and would be flooded to depths favored by mosquitos. Mosquito production levels, however, would be reduced because ponds would be initially flooded during periods of cold ambient temperature. Mosquito predator populations would become established before the mosquito breeding period begins.

Permanent Lakes. Two permanent lakes of 50 acres and 60 acres would be created on Bouldin Island. Lakes would be excavated and maintained with groundwater inflow and supplemented with irrigation as needed to maintain desired water levels. Lakes would be excavated to permanently maintain open-water areas and stands of emergent vegetation along shorelines and island edges.

Mosquitos are adapted to breed in habitats that are not ecologically stable. Immediately following lake construction, permanent ponds could potentially produce substantial numbers of mosquitos, but over time, mosquito predator populations would become established. Because lakes would be open-water areas and seasonally stable lake levels would be maintained, lake environments would stabilize and mosquito production would be expected to decline.

Permanent lakes are being constructed to provide values similar to those of lakes that would be inundated on Webb Tract. The existing lakes on Webb Tract do not produce mosquitos in sufficient numbers to require abatement (Kramer pers. comm.). If lakes constructed on Bouldin Island can be maintained in an ecological condition similar to lakes on Webb Tract, production of problem numbers of mosquitos would be unlikely after the lakes have stabilized.

Emergent Marsh. Approximately 400 acres of permanent emergent marsh would be created on Bouldin Island and Holland Tract. Marshes would be dominated by tule and cattail and would be flooded all year to depths ranging from 12 inches to 36 inches. To maintain between 40% and 70% in open-water areas, the marshes would be drawn down every few years to remove emergent vegetation.

Immediately following marsh construction or maintenance drawdown periods, marshes could potentially produce substantial numbers of mosquitos. Following maintenance drawdown periods, marshes would be rapidly reflooded, reducing the likelihood that substantial numbers of mosquitos would be produced during these periods (see Appendix G5, "Summary of Jurisdictional Wetland Impacts and Mitigation"). Because stable water levels and open water areas would be maintained, marsh environments would stabilize and mosquito production would be expected to decline. Substantial numbers of mosquitos, however, could be produced in dense stands of emergent vegetation, such as cattail and tule. This vegetation would protect larvae from wave action and predators, such as mosquitofish.

Borrow Ponds. Approximately 90 acres of borrow ponds may be created on Bouldin Island to provide borrow material for inner levee and perimeter levee maintenance and repair. Borrow ponds would be recharged with groundwater and surface runoff, so water levels would fluctuate seasonally. Borrow ponds would not be expected to produce problem numbers of mosquitos because periodic excavations would gradually deepen ponds and steepen shorelines. Steep shorelines would not support extensive stands of emergent vegetation.

Changes in the Need for Mosquito Abatement

Bacon Island and Webb Tract

Potential for Increase in Adult Mosquito Populations. The highest potential for production of problem numbers of mosquitos on the reservoir islands would occur in certain years when islands support partial-storage, shallow-storage, or shallow-water wetland conditions from June through October. These years would include periods when partial- and shallow-storage pool shorelines and shallow-water wetlands are heavily vegetated. Substantial mosquito production would not be expected during May because full-storage, partial-storage, shallow-storage, and shallow-water wetland conditions that would exist through winter would remove vegetation from the islands.

Potential for Increase in Mosquito Abatement Levels. The potential for an increase in mosquito abatement levels would fluctuate among years and would depend on the availability of water for storage on the reservoir islands. The greatest potential for increased need for abatement would be expected from September 1 to October 31 in years when islands could be managed as shallow-water wetlands (Tables 3N-2 and 3N-3).

Bouldin Island and Holland Tract

Potential for Increase in Adult Mosquito Populations. Creating permanent lakes, emergent marshes, and borrow ponds would result in a short-term impact on mosquito production because permanent wetlands tend to develop and maintain mosquito predator populations. Mosquito production will stabilize once natural predator/prey ratios reach equilibrium. However, the time required for newly created or restored permanent wetlands to mature is unpredictable (USFWS 1992).

Although mosquito production in permanent wetlands may stabilize at lower levels as the wetland ecosystems evolve, these sites may have the potential for long-term impacts because the definition of a mosquito production problem can be independent of the number of mosquitos produced. For example, if the human population adjacent to an existing mosquito production source were increased, the number of service calls to the responsible MAD from residents could increase without a change in existing mosquito production levels.

Seasonal wetlands, including flooded cornfields and wheat fields, have the highest potential to produce problem numbers of mosquitos from September 1 through October 31 because they duplicate habitat conditions most preferred by the species. Seasonal wetlands simulate water conditions that are associated with natural intermittent flood events and to which most species of mosquitos have adapted. Seasonal wetlands flooded from May 1 to May 31 would not be expected to produce problem numbers of mosquitos because most emergent vegetation would have been removed as a result of wave action and waterfowl forage activities.

Potential for Increase in Mosquito Abatement Levels. With implementation of Alternative 1, approximately 3,695 acres of potential mosquito breeding habitat would be created on the habitat islands during peak flood periods (i.e., October 16-31) (Tables 3N-4 and 3N-5). This represents approximately 2,100 more acres of potential mosquito habitat than were treated by MADs in 1991 (Holland Tract) and 1992 (Bouldin Island). Therefore, mosquito production might increase enough to require higher levels of mosquito abatement than are currently required.

Summary of Project Impacts and Recommended Mitigation Measures

Impact N-1: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands. Implementation of Alternative 1 would substantially reduce mosquito production and, subsequently, the need for abatement on the reservoir islands during full-storage periods. Therefore, this impact is considered beneficial.

Mitigation. No mitigation is required.

Impact N-2: Increase in Abatement Levels on the Habitat Islands and during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands. Implementation of Alternative 1 would result in an increase in mosquito breeding habitat on both the reservoir and habitat islands, at least during certain times of the year. Therefore, an increase in mosquito production would likely occur on the habitat islands and, during some years, on the reservoir islands under partial-storage, shallow-storage, or shallow-water wetland conditions. Substantially more people would be exposed to mosquitos as a result of the recreation programs for hunting, boating, and other uses on the DW project islands than are exposed under existing conditions (see Chapter 3J, "Recreation and Visual Resources", for details on the recreation program). Increased exposure of people to mosquitos would result in an increased need for abatement. Therefore, this impact is considered significant.

Implementing Mitigation Measure N-1 would reduce Impact N-2 to a less-than-significant level.

Mitigation Measure N-1: Coordinate Project Activities with SJCMAD and CCMAD. DW, DFG, and the HMAC shall consult and coordinate with SJCMAD and CCMAD during design, implementation, and operations phases of the project. DW will be responsible for coordination with MADs regarding mosquito control measures for the reservoir islands, and DW, DFG, and the HMAC will be responsible for coordination regarding the habitat islands. Consultation and coordination with SJCMAD and CCMAD shall include the following actions:

- Consult with SJCMAD and CCMAD during the project design phase to incorporate design elements of the reservoir and habitat islands to reduce the mosquito production potential of the project. Measures considered should include designing water delivery and drainage systems to allow for rapid manipulation of water levels on the habitat islands. The project design for the reservoir islands allows for the rapid manipulation of water levels in water storage areas.
- Permit SJCMAD and CCMAD personnel unrestricted access to the DW project islands to monitor or control mosquito populations.
- Regularly consult with SJCMAD and CCMAD to identify mosquito management problems, mosquito monitoring and abatement procedures, and opportunities to adjust operations to reduce mosquito production during problem periods.
- Consult with SJCMAD and CCMAD to identify annual mosquitofish stocking requirements.
- If it is necessary for SJCMAD and CCMAD to increase mosquito monitoring and control programs beyond preproject levels, consult with SJCMAD and CCMAD to identify opportunities for DW to share costs or otherwise participate in implementing mosquito abatement programs.

Incidence of Wildlife-Transmitted Diseases Affecting Humans

Public health issues of concern in the proposed DW project area include the transmission of human diseases, such as rabies, bubonic plague, and Lyme disease, by wildlife and other animals. Wildlife species that could transmit these diseases to humans are not expected to be present on the reservoir islands because their habitats would be eliminated as a result of water storage. However, habitats created on the habitat islands may increase the populations of wildlife species known to serve as hosts of wildlife-transmitted diseases. People using the habitat islands for recreation may experience increased exposure or closer proximity to these wildlife populations. However, such exposure would still not be considered a risk to public health in the Delta (Lucchesi and Reilly pers. comms.).

Summary of Project Impacts and Recommended Mitigation Measures

Impact N-3: Increase in Potential Exposure of People to Wildlife Species That Transmit Diseases. Under Alternative 1, the populations of wildlife species known to serve as hosts of wildlife-transmitted diseases affecting humans could increase on the habitat islands. Increased recreational use of these areas would increase the potential exposure of people to these species. However, transmission of wildlife-transmitted diseases such as Lyme disease, bubonic plague, and rabies is not now considered a significant risk to public health in the Delta, and the increase in risk under Alternative 1 would be minor. Therefore, the potential change in risk to public health from exposure to wildlife species on the habitat islands is considered less than significant.

Mitigation. No mitigation is required.

IMPACTS AND MITIGATION MEASURES OF ALTERNATIVE 2

The potential for mosquito production for each habitat condition class on the reservoir islands under Alternative 2 would be the same as described for Alternative 1. However, the frequency of each habitat condition class may differ (Tables 3N-6 and 3N-7). The habitat islands would be managed as described for Alternative 1.

The frequency with which mosquito breeding habitat would be created on Bacon Island would probably be increased because partial-storage, shallow-storage, and shallow-water wetland periods would increase. The frequency of these habitat conditions on Webb Tract would probably decrease from May through August but increase during September and October, when the island could be managed for shallow-water wetlands.

Although the frequency of creation of mosquito habitat would differ, impacts and mitigation measures under Alternative 2 are generally the same as those under Alternative 1. The impact associated with the incidence of wildlife-transmitted diseases would also be the same under Alternative 2.

IMPACTS AND MITIGATION MEASURES OF ALTERNATIVE 3

Alternative 3 would include storage of water on all four DW project islands, with secondary uses for wildlife habitat and recreation. The portion of Bouldin Island north of SR 12 would be managed as a wildlife habitat area (the NBHA) and would not be used for water storage.

Mosquito Breeding Conditions

The potential for mosquito production for each habitat condition class on the reservoir islands would be the same as described for Alternative 1. However, the frequency of occurrence of each class may differ (Tables 3N-8, 3N-9, 3N-10, and 3N-11).

Approximately 3,440 acres on Bouldin Island and 2,690 acres on Holland Tract during nonstorage periods could be flooded in fall to create shallow-water wetlands (JSA 1993). Although more acreage would be flooded under Alternative 3 than under Alternative 1 or 2, mosquito production levels would be expected to be lower because periodic inundation would result in lowered vegetation density and increased wave action.

On the portion of Bouldin Island north of SR 12 that would be managed as a wildlife habitat area, approximately 50 acres of perennial ponds, 330 acres of seasonal wetlands, and 170 acres of corn would be created on existing agricultural croplands.

Mosquito production associated with perennial ponds would be similar to that described for permanent lakes on the habitat islands under Alternatives 1 and 2. Seasonal wetlands and cornfields in the habitat area would be designed and managed as described for seasonal wetlands and cornfields on the habitat islands. Mosquito production would be the same.

Changes in the Need for Mosquito Abatement

The potential for an increase in mosquito abatement levels would depend on the availability of water for storage on the reservoir islands and would therefore fluctuate between years. The greatest potential for increased need for abatement would be expected to occur from September 1 to October 31 in years when the islands could be managed for shallow-water wetlands.

Impacts and the mitigation measure for the reservoir islands under Alternative 3 are similar to those described under Alternative 1.

Summary of Project Impacts and Recommended Mitigation Measures

Impact N-4: Reduction or Elimination of Mosquito Abatement Activities during Full-Storage Periods on the Reservoir Islands. This impact is described above under Impact N-1. This impact is considered beneficial.

Mitigation. No mitigation is required.

Impact N-5: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands and in the NBHA. This impact is similar to Impact N-2, described above. This impact is considered significant.

Implementing Mitigation Measure N-1 would reduce Impact N-5 to a less-than-significant level.

Mitigation Measure N-1: Coordinate Project Activities with SJCMAD and CCMAD. This mitigation measure is described above under "Impacts and Mitigation Measures of Alternative 1".

Incidence of Wildlife-Transmitted Diseases Affecting Humans

Wildlife species that could transmit diseases to humans are not expected to be present on the reservoir islands under Alternative 3 because their habitats would be substantially reduced as a result of water storage. Habitats created on the NBHA may increase the populations of these species in that area , but that increase would be negligible relative to the reduction in populations resulting from water storage. Therefore, implementing Alternative 3 would not affect the incidence of wildlife-transmitted diseases affecting humans.

IMPACTS AND MITIGATION MEASURES OF THE NO-PROJECT ALTERNATIVE

The No-Project Alternative would increase the acreage of land cultivated for annual grains, perennial crops, orchards, and vineyards. Irrigated pasture and marsh habitats would be reduced by 1,764 acres and acreage of open-water habitats would be similar to existing acreage (Table 3N-12).

The project applicant would not be required to implement mitigation measures if the No-Project Alternative were selected by the lead agencies. However, mitigation measures are presented for impacts of the No-Project Alternative to provide information to the reviewing agencies regarding the measures that would reduce impacts if the project applicant implemented a project that required no federal or state agency approvals. This information would allow the reviewing agencies to make a more realistic comparison of the DW project alternatives, including implementation of recommended mitigation measures, with the No-Project Alternative.

Mosquito Breeding Conditions

Bacon Island and Webb Tract

Existing marsh habitats (34 acres) and irrigated pastures (61 acres) would be eliminated from Bacon Island and Webb Tract, respectively, and marsh habitats would be reduced by 899 acres (94.1%) on Webb Tract under the No-Project Alternative (Table 3N-12). Although SJCMAD and CCMAD currently do not consider either island to be a significant mosquito production source (Lucchesi and Waletzko pers. comms.), conversion of these habitats to agricultural uses could reduce the potential for future mosquito production problems on these islands (Kramer pers. comm.).

Bouldin Island and Holland Tract

Implementing the No-Project Alternative would eliminate existing marsh habitats and irrigated pastures (170 acres) on Bouldin Island. Marsh habitat and irrigated pastures on Holland Tract would be reduced by 285 acres (99.3%) and 315 acres (55.1%), respectively (Table 3N-12). Both islands support problem mosquito production sources that require frequent monitoring and treatment by SJCMAD and CCMAD (Lucchesi and Waletzko pers. comms.).

Changes in the Need for Mosquito Abatement

Potential for Reduction of Existing Mosquito Breeding Habitat

Implementing the No-Project Alternative could result in lower levels of mosquito abatement by eliminating habitats that have the potential to produce problem numbers of mosquitos and reducing or eliminating habitats currently identified by SJCMAD and CCMAD as problem mosquito production sources (Figure 3N-1).

Potential for an Increase in Adult Mosquito Populations as a Result of Increased Corn Production

An increase of 127% in annual grain production, and specifically an increase in corn cultivation, primarily on Holland and Webb Tracts (Table 3N-12), could result in increased mosquito production during the fall pre-irrigation and weed control periods. As a result, higher levels of mosquito abatement may be required.

Summary of Project Impacts and Recommended Mitigation Measures

Reduction in Mosquito Abatement Activities on the DW Project Islands. Implementation of the No-Project Alternative would reduce mosquito production by eliminating habitats that have the potential to produce problem numbers of mosquitos. Subsequently, the need for abatement on the DW project islands would be reduced.

Increase in Mosquito Production Levels as a Result of Increased Corn Production. Implementation of the No-Project Alternative could involve increased fall flooding to control weeds in cornfields, which could result in substantial increases in mosquito production.

Implementing the following mitigation measure would reduce this effect of the No-Project Alternative.

Coordinate Project Activities with SJCMAD and CCMAD. DW should notify SJCMAD and CCMAD of proposed fall cornfield flooding schedules at least 2 months in advance. Additionally, DW should allow SJCMAD and CCMAD to have access to the DW islands to monitor mosquito production, control mosquitos, and conduct other related abatement activities.

Incidence of Wildlife-Transmitted Diseases Affecting Humans

Under the No-Project Alternative, populations of wildlife species that could transmit diseases to humans are not expected to increase. Increased agricultural production may reduce populations by disturbing or eliminating their habitats through plowing and vegetation removal. Therefore, implementing the No-Project Alternative would not affect the incidence of wildlife-transmitted diseases affecting humans.

CUMULATIVE IMPACTS

This section briefly analyzes cumulative impacts related to mosquito production and abatement issues. The analysis identifies other projects or activities in the Delta region and surrounding areas that may affect mosquito production conditions that may also be affected by the DW project. These projects are summarized in Appendix 2, "Supplemental Description of the Delta Wetlands Project Alternatives". Beneficial and negative cumulative effects are identified, and the overall effect of DW project impacts on regional habitats is described.

Cumulative Impacts, Including Impacts of Alternative 1

Changes in Reservoir Island Storage Conditions

DWR recently installed four additional pumping units at SWP's Banks Pumping Plant near Clifton Court Forebay, increasing total SWP pumping capacity from 6,400 cfs to 10,300 cfs. If SWP export pumping is increased to full capacity in future years, the frequency with which each storage class would occur on the DW project islands would change. Tables 3N-2 and 3N-3 present the storage class frequencies for the reservoir islands under this cumulative scenario for Alternative 1 based on the 70-year hydrologic record for the Delta. In most months the frequency with which full-, partial-, and shallow-storage conditions would occur would be reduced and the occurrence of nonstorage conditions and the opportunity to create shallow-water wetland conditions would be increased. Consequently, the availability of mosquito breeding habitat would generally be reduced from May through August and would be increased during September and October under Alternative 1.

Impact N-6: Increase in Abatement Levels during Partial-Storage, Shallow-Storage, or Shallow-Water Wetland Periods on the Reservoir Islands under Cumulative Conditions. If SWP export pumping is increased to full capacity in future years, the availability of mosquito breeding habitat would generally be reduced from May through August and increased during September and October. As described under Impact N-2, increased need for abatement is considered a significant impact.

Implementing Mitigation Measure N-1 would reduce Impact N-6 to a less-than-significant level.

Mitigation Measure N-1: Coordinate Project Activities with SJCMAD and CCMAD. This impact is described above under "Impacts and Mitigation Measures of Alternative 1".

Related Future Projects

Related future projects that may contribute cumulatively to impacts on mosquito abatement programs described in this chapter include wetland habitat restoration programs that would increase mosquito breeding habitat within mosquito flight ranges of SJCMAD or CCMAD jurisdictional boundaries.

DWR has proposed projects to develop seasonal and permanent wetland habitats on Sherman Island and Twitchell Island in the west Delta (DWR 1990). Implementing these projects would create up to 10,000 acres of wetlands on Sherman Island and 3,600 acres on Twitchell Island in Sacramento County. Without mitigation, these projects could significantly increase MAD abatement requirements if mosquito production on restored wetlands results in a greater potential for disease transmittal by mosquitos or an increase in the number of service requests to MADs.

Additionally, mosquito abatement programs may be affected by projects that increase human populations near existing mosquito production areas. Residential housing developments are proposed for Hotchkiss Tract and Bethel Island west of Holland Tract. Service calls generated from new developments could substantially increase abatement costs to MADs.

Impact N-7: Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the DW Project. Implementing future projects that benefit mosquito breeding conditions (e.g., wetland habitat restoration projects) or that increase human populations near existing mosquito production areas (e.g., residential housing and marina developments) contribute to the need for mosquito abatement in the DW project area. Mitigation should be implemented for each project during the project evaluation and approval process to minimize the cumulative effects on mosquito abatement. However, because there is no guarantee that mitigation measures would be implemented for other future projects, this impact is considered significant and unavoidable.

Mitigation. No mitigation is available to reduce this impact to a less-than-significant level.

Cumulative Impacts, Including Impacts of Alternative 2

As shown on Tables 3N-6 and 3N-7, the changes in frequencies with which habitat condition classes for the reservoir islands could occur under the cumulative scenario for Alternative 2 would be similar to the changes in frequencies shown for Alternative 1 (i.e., the availability of mosquito breeding habitat on the reservoir islands would generally be reduced from May through August and increased during September and October).

The cumulative impacts associated with this alternative would be the same as those described for cumulative conditions with Alternative 1.

Cumulative Impacts, Including Impacts of Alternative 3

As shown on Tables 3N-8 through 3N-11, the frequencies with which habitat condition classes for the reservoir islands could occur under the cumulative scenario for Alternative 3 would be similar to changes in frequencies shown for cumulative conditions with Alternative 1 (i.e., the availability of mosquito breeding habitat on the reservoir islands would generally be reduced from May through August and increased during September and October).

The cumulative impacts associated with this alternative would be the same as those described for cumulative impacts with Alternative 1.

Cumulative Impacts, Including Impacts of the No-Project Alternative

Cumulative Increase in Mosquito Abatement Needs Resulting from Implementation of Future Projects, Including the No-Project Alternative. Implementing future projects that benefit mosquito breeding conditions (e.g., wetland habitat restoration projects) or that increase human populations near existing mosquito production areas (e.g., residential housing and marina developments) contribute to the need for mosquito abatement in the DW project area. The No-Project Alternative could contribute to this cumulative effect by increasing mosquito production levels on the four DW project islands during fall flooding.

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Table 3N-1. Acreages of Wetlands and Other Potential Mosquito Breeding Sites on the DW Project Islands

Habitat Type[c]	Bacon Island[a]		Webb Tract[a]		Bouldin Island[a]		Holland Tract[a, b]		All Islands[a]	
	Acres	Percentage of Total	Acres	Percentage of Total	Acres	Percentage of Total	Acres	Percentage of Total	Acres	Percentage of Total
Canals and ditches	91.8	1.66	49.7	0.91	118.1	1.97	39.4	1.26	299.0	1.49
Ponds	1.5	0.03	105.7	1.93	0.0	0.00	16.6	0.53	123.8	0.62
Freshwater marsh	2.7	0.05	172.0	3.14	21.1	0.35	27.8	0.89	223.6	1.11
Exotic marsh	30.4	0.55	783.3	14.32	114.7	1.92	195.5	6.24	1,123.9	5.58
Irrigated pasture	0.0	0.00	61.0	1.12	34.2	0.57	349.8	11.16	445.0	2.21
Cropland[d]	3,091.5	55.81	2,694.7	49.27	4,530.3	75.69	550.9	17.57	10,867.4	53.99
Other habitat types[e]	2,321.5	41.91	1,602.6	29.30	1,166.6	19.49	1,955.2	62.36	7,045.9	35.00
Totals	5,539.4	100	5,469.0	100	5,985.0	100	3,135.2	100	20,128.6	100

[a] Acreages are derived from Table 3G-4 in Chapter 3G, "Vegetation and Wetlands".

[b] Acreages are not provided for the portion of Holland Tract that would be included under Alternative 3. Habitat acreages for Alternative 3 are presented in Table 3G-4 in Chapter 3G, "Vegetation and Wildlife".

[c] Habitat types are defined in Chapter 3G, "Vegetation and Wetlands".

[d] Includes corn, wheat, milo, potato, and sunflower crops.

[e] Other habitat types include developed areas and riparian, upland, fallow, and other cropland habitats.

C—061016

Table 3N-2. Frequency of Habitat Condition Classes on Bacon Island under Alternative 1 and Cumulative Conditions for Alternative 1 (Percentage of Years)

Month	Alternative 1					Cumulative Alternative 1				
	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	74.3	4.3	1.4	20.0	0.0	67.1	0.0	1.4	31.4	0.0
June	70.0	8.7	0.0	21.4	0.0	64.3	2.9	0.0	32.9	0.0
July	45.7	11.4	8.6	34.3	0.0	2.9	0.0	0.0	97.1	0.0
August	15.7	2.9	5.7	75.7	0.0	1.4	0.0	0.0	98.6	0.0
September	11.4	2.9	0.0	61.4	24.3	4.3	4.3	0.0	0.0	91.4
October	30.0	1.4	0.0	22.9	45.7	18.6	1.4	0.0	2.9	77.1

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

Table 3N-3. Frequency of Habitat Condition Classes on Webb Tract under Alternative 1 and Cumulative Conditions for Alternative 1 (Percentage of Years)

	Alternative 1					Cumulative Alternative 1				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	48.6	15.9	1.4	34.3	0	45.7	11.4	1.4	41.4	0
June	37.1	21.7	2.9	38.6	0	35.7	11.4	4.3	48.6	0
July	7.1	22.9	1.4	68.6	0	1.4	0	0	98.6	0
August	2.9	5.7	0	91.4	0	1.4	0	0	98.6	0
September	8.6	2.9	0	37.1	51.4	2.9	1.4	0	0	95.7
October	22.9	5.7	0	7.1	64.3	11.4	2.9	0	1.4	84.3

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

C-061019

Table 3N-4. Flooded Habitat Acreages by Date on Bouldin Island under Alternatives 1 and 2 during the Mosquito Breeding Season

	Acres by Management Period[b]							
	5/1-5/15	5/16-5/30	6/1-7/30	8/1-8/30	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31
Seasonal managed wetland and mixed agriculture/seasonal wetland	432	432	0	0	432	432	686	1,446
Corn rotated with wheat	0	0	0	0	102	204	509	712
Pasture/hay[c]	0	0	0	0	0	0	0	0
Seasonal ponds	66	66	66	0	0	0	0	0
Permanent lakes	111	111	111	111	111	111	111	111
Emergent marsh	208	208	208	208	208	208	208	208
Borrow ponds	89	89	89	89	89	89	89	89
Total	906	906	474	408	942	1,044	1,603	2,632

[a] Habitat types are described in Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands".

[b] Acreages are derived from Table 3 in Appendix G3.

[c] Approximately 205 acres of pasture/hay would be flooded on habitat islands for wildlife after the mosquito breeding season. Mosquito breeding habitat, however, would be created during spring and summer irrigation periods.

C-061019

Table 3N-5. Flooded Habitat Acreages by Date on Holland Tract under Alternatives 1 and 2 during the Mosquito Breeding Season

	Acres by Management Period[b]							
	5/1-5/15	5/16-5/30	6/1-7/30	8/1-8/30	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31
Seasonal managed wetland and mixed agriculture/seasonal wetland	100	100	0	0	100	100	258	416
Corn rotated with wheat	0	0	0	0	60	119	298	418
Pasture/hay[c]	0	0	0	0	0	0	0	0
Seasonal ponds	68	68	68	0	0	0	0	0
Permanent lakes	33	33	33	33	33	33	33	33
Emergent marsh	194	194	194	194	194	194	194	194
Borrow ponds	0	0	0	0	0	0	0	0
Total	395	395	295	227	397	446	783	1,061

[a] Habitat types are described in Appendix G3, "Habitat Management Plan for the Delta Wetlands Habitat Islands".

[b] Acreages are derived from Table 3 in Appendix G3.

[c] Approximately 205 acres of pasture/hay would be flooded on habitat islands for wildlife after the mosquito breeding season. Mosquito breeding habitat, however, would be created during spring and summer irrigation periods.

C-061020

C-061021

Table 3N-6. Frequency of Habitat Condition Classes on Bacon Island under Alternative 2 and Cumulative Conditions for Alternative 2 (Percentage of Years)

	Alternative 2					Cumulative Alternative 2				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	54.3	7.1	1.4	37.1	0.0	44.3	2.9	0.0	52.9	0.0
June	30.0	7.1	2.9	60.0	0.0	20.0	1.4	0.0	78.6	0.0
July	15.7	7.1	37.1	40.0	0.0	2.9	0.0	0.0	97.1	0.0
August	4.3	2.9	8.6	84.3	0.0	1.4	0.0	0.0	98.6	0.0
September	11.4	2.9	0.0	57.1	28.6	4.3	4.3	0.0	0.0	91.4
October	30.0	1.4	0.0	14.2	54.3	18.6	1.4	0.0	1.4	78.6

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

C-061021

Table 3N-7. Frequency of Habitat Condition Classes on Webb Tract under Alternative 2 and Cumulative Conditions for Alternative 2 (Percentage of Years)

Month	Alternative 2					Cumulative Alternative 2				
	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	38.6	11.4	0	50.0	0	28.6	7.1	1.4	62.9	0
June	17.1	10.0	0	72.9	0	11.4	2.9	0	85.7	0
July	2.9	4.3	2.9	90.0	0	1.4	0	0	98.6	0
August	1.4	1.4	1.4	95.7	0	1.4	0	0	98.6	0
September	8.6	2.9	0	10.0	78.6	2.9	1.4	0	0	95.7
October	20.0	5.7	0	4.3	75.7	11.4	2.9	0	1.4	84.3

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

Table 3N-8. Frequency of Habitat Condition Classes on Bacon Island under Alternative 3 and Cumulative Conditions for Alternative 3 (Percentage of Years)

	Alternative 3					Cumulative Alternative 3				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	62.9	4.3	1.4	31.4	0	47.1	2.9	0	50.0	0
June	48.6	2.9	0	48.6	0	21.4	8.6	1.4	68.6	0
July	31.4	38.6	0	30.0	0	5.7	7.1	0	87.1	0
August	11.4	10.0	1.4	77.1	0	1.4	0	0	98.6	0
September	11.4	5.7	0	54.3	28.6	4.3	4.3	0	7.1	84.3
October	30.0	1.4	0	15.7	52.9	18.6	1.4	0	1.4	78.6

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

Table 3N-9. Frequency of Habitat Condition Classes on Webb Tract under Alternative 3 and Cumulative Conditions for Alternative 3 (Percentage of Years)

	Alternative 3					Cumulative Alternative 3				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	54.3	4.3	0	41.4	0	42.9	4.3	0	52.9	0
June	32.9	4.3	0	62.9	0	18.6	2.9	0	78.6	0
July	18.6	4.3	0	77.1	0	2.9	0	1.4	95.7	0
August	2.9	2.9	0	94.3	0	1.4	0	0	98.6	0
September	8.6	2.9	0	12.9	75.7	2.9	1.4	0	2.9	92.9
October	21.4	5.7	0	4.3	68.6	11.4	2.9	0	1.4	84.3

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

C-061024

Table 3N-10. Frequency of Habitat Condition Classes on Bouldin Island under Alternative 3 and Cumulative Conditions for Alternative 3 (Percentage of Years)

	Alternative 3					Cumulative Alternative 3				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	42.9	5.8	0	51.4	0	32.9	2.9	0	67.1	0
June	18.6	7.2	1.4	72.9	0	11.4	5.8	0	82.9	0
July	4.3	5.7	0	90.0	0	1.4	0	0	98.6	0
August	1.4	1.4	0	97.1	0	1.4	0	0	98.6	0
September	4.3	1.4	1.4	5.7	87.1	1.4	0	0	0	98.6
October	17.1	1.4	1.4	2.9	77.1	5.7	0	0	1.4	92.9

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

Table 3N-11. Frequency of Habitat Condition Classes on Holland Tract under Alternative 3 and Cumulative Conditions for Alternative 3 (Percentage of Years)

	Alternative 3					Cumulative Alternative 3				
Month	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland	Full Storage	Partial Storage	Shallow Storage	Nonstorage	Shallow-Water Wetland
May	20.0	7.2	1.4	71.4	0	12.9	8.6	1.4	77.1	0
June	10.0	4.3	0	85.7	0	7.1	0	0	92.9	0
July	2.9	1.4	0	95.7	0	1.4	0	0	98.6	0
August	1.4	0	0	98.6	0	0	0	0	100.0	0
September	1.4	0	0	2.9	95.7	1.4	0	0	0	98.6
October	11.4	1.4	4.3	1.4	81.4	4.3	0	1.4	1.4	92.9

Note: Percentages may not total 100 because of rounding.

Frequencies were estimated based on the 70-year hydrologic record presented in Appendix G4, "Simulated End-of-Month Water Storage on Reservoir Islands for the Delta Wetlands Project Alternatives". The frequency with which each habitat condition class would occur in future years, however, is unpredictable. Frequencies do not include periods when reservoir islands may be used for water transfers or banking. If reservoir islands are used to transfer or bank water, the frequency of storage periods could be expected to increase and the frequency of nonstorage and shallow-water wetland periods could be expected to decrease.

Table 3N-12. Predicted Changes in Acreages of Habitat Types under the No-Project Alternative

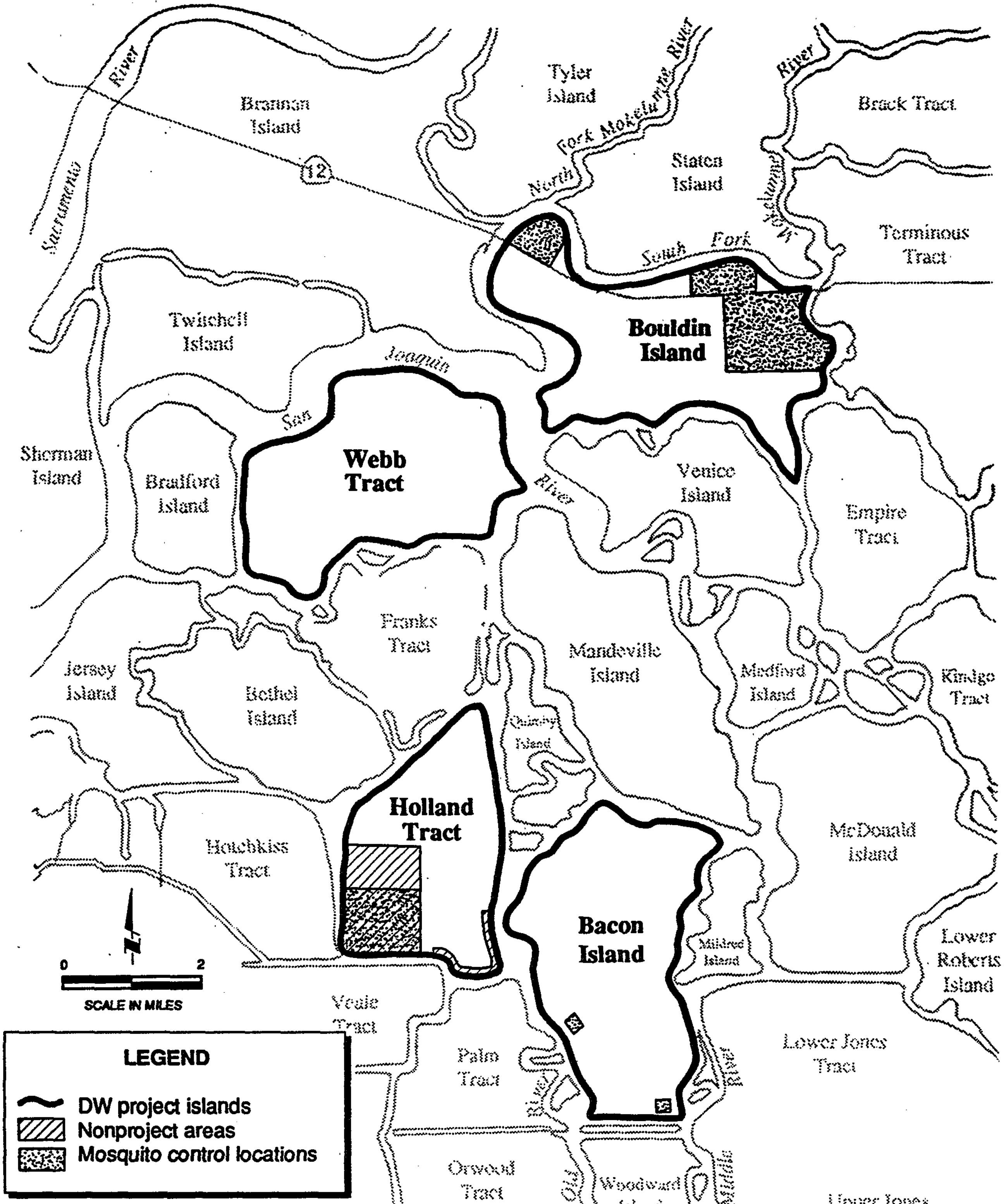
	Bacon Island		Webb Tract		Bouldin Island		Holland Tract		Total		
Habitat Type[a]	1987 Acreage	No-Project Acreage	1987 Acreage	No-Project Acreage	1987 Acreage	No-Project Acreage	1987 Acreage	No-Project Acreage	1987 Acreage	No-Project Acreage	Estimated Change between 1987 and No-Project Acreages
Ditches and sloughs	92	92	50	50	118	118	45	45	305	305	0
Ponds	2	2	106	106	0	0	23	23	131	131	0
Freshwater marsh	3	0	172	16	21	0	28	2	224	18	-206
Exotic marsh	30	0	783	40	115	0	259	0	1,188	40	-1,148
Irrigated pasture	0	0	61	0	34	0	571	256	666	256	-410
Crops, orchards, vineyards	4,439	5,095	2,695	4,961	4,530	5,426	1,541	3,693	13,205	19,175	5,970
Fallowed lands	355	0	638	0	712	0	785	0	2,490	0	-2,490
Other habitat types[b]	617	351	965	296	455	440	998	230	3,035	1,317	-1,718
Total	5,539	5,540	5,470	5,469	5,985	5,984	4,250	4,249	21,244	21,242	

Notes: Minor discrepancies in totals are the result of rounding.

[a] Habitat types are defined in Chapter 3G, "Vegetation and Wetlands".

[b] Includes developed lands and riparian and upland habitats.

C—061027



Note: The nonproject areas on Holland Tract are included in the DW Project for Alternative 3 and the No-Project Alternative.

Source: Lucchesi and Kramer pers. comms.

Figure 3N-1.
Mosquito Control Locations on the DW Project Islands, 1991-1992

DELTA WETLANDS
PROJECT EIR/EIS
Prepared by: Jones & Stokes Associates